SECTION 5.0

Electric Transmission

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5.1 Introduction

Section 5.0 discusses the transmission interconnection between the Walnut Energy Center (WEC) and the existing electrical grid, and the anticipated impacts that operation of the facility will have on the flow of electrical power in the central region of California. To better understand the impacts of the proposed WEC on the transmission and power flows, the discussions in this section will focus on those areas that allow a critical review of the electrical transmission and interconnection. More specifically, this analysis will contain discussions on:

- The existing electrical transmission system in the immediate area of WEC
- The proposed electrical interconnection between WEC and the electrical grid
- The proposed electrical transmission line alignment
- The impacts of the electrical interconnection on the existing transmission grid
- Potential nuisances (electrical, magnetic, audible noise, and corona effects)
- Safety of the interconnection
- Description of applicable laws, ordinances, regulations, and standards (LORS)

The proposed WEC site is located in an industrial area of the City of Turlock, California in central Stanislaus County. This location was selected, in part, for its proximity to (1) the Turlock Irrigation District (TID) load area, (2) reliable high-voltage transmission lines, and (3) the Walnut 230/115/69-kV Substation. Figure 5.1-1 (all figures are located at the end of the section) shows the location of WEC in relationship to the Walnut Substation and the existing 115- and 69-kV transmission lines. Figure 5.1-1 demonstrates that the WEC site is in close proximity to both the Walnut Hilmar 115-kV and Walnut Industrial 69-kV lines. This physical proximity (1,950 feet east of the Walnut Hilmar 115-kV and 670 feet north of the Walnut Industrial 69-kV Line 2) will allow for short interconnecting transmission lines to WEC.

The initial examination of the local transmission system concentrated on the anticipated WEC power flows, capacity, and location of existing transmission lines; availability of substation capacity; and physical distances involved with the anticipated electrical interconnection. As proposed, new electrical transmission interconnections will link WEC to the power grid by looping the nearby Walnut Hilmar 115-kV and the Walnut Industrial 69-kV Line 2 transmission lines into the WEC switchyard (Figure 5.3-1). The physical components of the interconnection will involve one double-circuit 115-kV line approximately 1,950-feet long and one double-circuit 69-kV line approximately 670-feet long. The proposed 115-kV connection will align in an east-west direction and cross open farmland, along an existing electrical easement, adjacent to the Tidewater Southern (owned by Union Pacific Railroad). The proposed 69-kV connection will align in a north-south direction and cross open farmland. Figure 5.1-1 illustrates alignment of the proposed interconnection in relationship to the proposed WEC site, the nearby existing 115-kV and

69-kV transmission lines, and the Walnut and Industrial substations. In Figure 5.1-2, these features are superimposed on an aerial photograph of the area in the immediate vicinity of WEC. This allows the reader to compare the proposed components (plant site, connection corridor, and Walnut Substation) with geographic features, agricultural fields, and recent development of this part of Stanislaus County.

The proximity of 69- and 115-kV transmission lines to the WEC project conceptually allows for a relatively short interconnection to be considered with respect to its feasibility, anticipated impact on the existing transmission system, and projected power flows. Attached in a separate map pocket at the end of this section is the Operating Diagram for TID's transmission system. Further analysis based on the WEC characteristics and discussion of the proposed interconnections are found in Sections 5.2 and 5.3.

5.2 Transmission Interconnection Engineering

This subsection discusses the existing transmission facilities in the vicinity of the WEC project and the conceptual design of the interconnection transmission line.

The proposed WEC site is approximately 18 acres in size and is located approximately 1,950 feet east and 670 feet south of TID's Walnut Substation in central Stanislaus County, California. This 18-acre site is contained within a 69-acre parcel. An inventory and assessment of the transmission facilities in the immediate geographic area of the WEC project was conducted. The transmission line assessment focused on the number of electrical transmission lines, the rating of each line, the existing loads, and the ability of the existing transmission grid to safely and reliably transport the anticipated base load of 250 MW of power to be generated at WEC.

The interconnection between the proposed WEC and the TID transmission system will consist of the following major transmission facilities: Two new double-circuit overhead lines extending approximately 1,950 and 670 feet to loop the Walnut Hilmar 115-kV and the Walnut Industrial 69-kV Line 2 transmission lines into the WEC switchyard (see Figures 5.1-1 and 5.1-2).

As a result of the WEC switchyard physical orientation on the proposed site, the 115-kV-transmission interconnection will exit the switchyard in a westerly direction, and the 69-kV transmission interconnection will exit the switchyard in a southerly direction. The double-circuit 115-kV line will continue to the west approximately 1,950 feet where it transitions to the existing Walnut Hilmar 115-kV line. One of the existing 115-kV lines proceeds approximately 750 feet to terminate in the Walnut Substation. The other existing line terminates approximately 6 miles south and east at Hilmar Substation. Upon leaving the WEC switchyard, the double-circuit 69-kV line will proceed due south approximately 670 feet to intersect with the existing Walnut Industrial 69-kV Line 2 transmission line, where one existing line proceeds approximately 4,500 feet west and then north to terminate in the Walnut Substation while the other existing line terminates approximately 1.7 miles to the southeast (about 2.6 circuit miles) in the Industrial Substation. As a result of the WEC project, the existing Walnut Hilmar 115-kV line will become two line segments designated as the WEC Hilmar 115-kV and the WEC Walnut 115-kV. The Walnut Industrial 69-kV Line

2 will become two segments designated the WEC Industrial 69-kV and the WEC Walnut 69-kV (see Figure 5.1-2).

5.2.1 115 kV and 69 kV

The proposed conductor for the new double-circuit 115-kV line and the new 69-kV double-circuit transmission line is 954 kcmil, AA "Magnolia" (diameter of 1.124 in.), matching the conductor of the existing lines. Wood poles will be used for the tangent poles and weathering steel (brown in color) will be used for heavy angles and at the take-off structures where the new lines will tie to the existing lines (Figures 5.2-1, 5.2-2, and 5.5-2 through 5.5-5). Since the new lines will extend from the existing right-of-way directly onto the adjacent 69-acre parcel, no additional right-of-way acquisition is necessary.

5.2.2 12 kV

For construction power and for auxiliary plant power, existing 12-kV facilities will be extended to the WEC site. The new 69-kV transmission pole line will be designed for installation of a 12-kV underbuild extended from the existing 12-kV underbuild on the Walnut Industrial 69-kV Line 2. The new 115-kV transmission pole line will also be designed for the underbuild 12-kV extended east from Washington Road. An existing 12-kV single-phase line already extends into the center of the 69-acre parcel from Washington Road and serves a well that is currently not in use. This existing line may be used for construction trailers and temporary water supply, but will be removed or replaced by a 12-kV underbuild of one of the above lines after WEC construction. All new overhead 12-kV conductors will be #2 ACSR "Sparate" (diameter 0.325 in.).

5.2.3 Exiting the WEC Switchyard

The 115-kV lines will exit the WEC switchyard terminal on a reduced-tension dead-end take-off structure located on the west end of the switchyard. Steel poles with concrete foundations will support the 115-kV lines as they transition to alignment with the west-going line. The 69-kV lines will exit the WEC switchyard from a reduced-tension dead-end take-off structure and connect to a dead-end slack-to-tension pole immediately outside the switchyard. The line will then proceed south under tension.

5.2.4 Interconnection with Existing Lines

The 115-kV line will proceed from the WEC switchyard under tension approximately 1,950 feet west to a new angle/dead-end structure to be interset into the existing Hilmar Walnut 115-kV line just west of Washington Road and just south of the Union Pacific Railroad tracks (see Figure 5.2-1). This inset structure will be steel with a concrete foundation and will support the Walnut Pioneer 115-kV and Walnut Industrial 69-kV Line 1 lines on the west side, the WEC Hilmar 115-kV, WEC Walnut 115-kV, and WEC Walnut 69-kV lines on the east side, and a 12-kV feeder. All conductors will be in a vertical configuration except for the 12-kV feeder. The location of this structure is illustrated in Figure 5.1-2 at the point labeled "Figure 5.2-1."

The 69-kV line will proceed from WEC under tension approximately 670 feet south to a new angle/dead-end structure to be interset into the existing Walnut Industrial 69-kV Line 2 approximately 2,600 feet north of Linwood Ave. This inset structure will be steel with a concrete foundation and will support the proposed WEC Walnut and WEC Industrial 69-kV lines, and a 12-kV feeder. All conductors will be in the vertical configuration except for the 12-kV feeder. The location of this structure is illustrated in Figure 5.1-2 at the point labeled "Figure 5.2-2."

5.3 Walnut Energy Center 115- and 69-kV Switchyard

The WEC switchyard will consist of four 115-kV circuit breakers rated at 40 kA and connected in a ring bus scheme to enhance reliability. This ring bus will interface to the WEC Hilmar 115-kV line and WEC Walnut 115-kV line. In addition, there will be four 69-kV circuit breakers rated at 40 kA also arranged in a ring bus configuration. The 69-kV ring bus will interface with the WEC Walnut 69-kV line and the WEC Industrial 69-kV line.

Finally the switchyard will include one 115/13.8-kV, one 69/13.8-kV, and one 115/69/13.8-kV generator step-up transformer. One of the combustion turbine (CT) generators and the steam turbine generator will operate on the 115-kV system during normal conditions. The remaining CT generator will operate on the 69-kV system. When the 69-kV CT generator is down for maintenance, the steam turbine generator will operate on the 69-kV system through the generator step up (GSU)/autotransformer. A large-scale illustration of the TID Walnut Energy Center basic single-line diagram is shown in Figure 5.3-1.

5.4 Interconnection System Impact Study

At the request of TID, Utility System Efficiencies, Inc. (USE) performed an initial interconnection system impact study for the WEC. The base cases used in this study included a 2006 summer-peak case (2006 Heavy Summer base case with one-in-ten year load levels for both the Bay Area and Central Valley) and a 2006 spring-load case (2006 Heavy Spring). To help develop this base case and review study results, a study group was formed consisting of Pacific Gas & Electric Company (PG&E), California Independent System Operator (CAISO), TANC, Sacramento Municipal Utility District (SMUD), MID, and WAPA. This group provided input with respect to generation patterns, load levels, and modeled transmission projects. TID will continue to work with this group as they review the study results. The study report, which outlines all study procedures and results of the interconnection of WEC to the existing power grid, is included in Appendix 5A.

The purpose of the study was to identify any system reliability concerns as well as potential congestion impacts resulting from the addition of WEC. The physical components of the interconnection will involve one double-circuit 115-kV line and one double-circuit 69-kV line looping the WEC switchyard. The anticipated date of operation for WEC is the first quarter 2006.

The system impact study assessed WEC's impact on:

- Thermal loading on power system equipment (i.e., transmission lines, transformers, series capacitors)
- Post-transient voltage performance

- Transient stability of the power system (i.e., a critical contingency does not result in excessive oscillations or system collapse as a result of a new generator interconnecting to the grid)
- Fault duty of power system equipment (i.e., breakers, switches)

For the interconnection of the 250-MW WEC to the power system grid, only one transmission system impact was identified throughout the course of the technical analysis. For loss of one of the planned EAEC-Tracy 230-kV transmission lines, the remaining parallel EAEC-Tracy 230-kV transmission line overloads beyond its thermal capability (Table 5.4-1).

TABLE 5.4-1
Loss of EAEC-Tracy 230kV Line #1 (or #2)

Season	Overloaded Element	Pre-Project Loading	Post-Project Loading	Delta
2006 Heavy Summer	EAEC-Tracy 230-kV #2 (or #1)	107.1%	115.4%	+8.3%
2006 Heavy Spring	EAEC-Tracy 230-kV #2 (or #1)	118.1%	128.3%	+10.2%

The EAEC-Tracy 230-kV transmission lines are planned facilities for the interconnection of the East Altamont Energy Center generation project. Final engineering and design for this generation project interconnection are not complete as of the writing of this report and are subject to change and/or revision. Nonetheless, TID commits to work with the California Energy Commission (CEC), CAISO, and its neighboring systems and generation developers to ensure that the interconnection of WEC will not adversely impact transmission system performance.

5.5 Transmission Line Safety and Nuisance

This section discusses safety and nuisance issues associated with the proposed electrical interconnection of WEC with the electrical grid. Construction and operation of the proposed overhead transmission lines will be undertaken in a manner to ensure the safety of the public as well as maintenance and right-of-way crews while supplying power with minimal electrical interference.

5.5.1 Electrical Clearances

Typical high-voltage overhead transmission lines are composed of bare conductors connected to supporting structures by means of porcelain, glass, or plastic insulators. The air surrounding the energized conductor acts as the insulating medium. Maintaining sufficient clearances, or air space, around the conductors to protect the public and utility workers is paramount to ensure safe operation of the line. The safety clearance required around the conductors is determined by normal operating voltages, conductor temperatures, short-term abnormal voltages, wind-blown swinging conductors, contamination of the insulators, clearances for workers, and clearances for public safety. Minimum clearances are specified in the National Electric Safety Code (NESC) and California Public Utilities Commission (CPUC) General Order 95 (GO 95). Electric utilities, state regulators, and local ordinances may specify additional (more restrictive) clearances. Typically, clearances are specified for:

- Distance between the energized conductors themselves
- Distance between the energized conductors and the supporting structure
- Distance between the energized conductors and other power or communication wires on the same supporting structure, or between other power or communication wires above or below the conductors
- Distance from the energized conductors to the ground and features such as roadways, railroads, driveways, parking lots, navigable waterways, airports, etc.
- Distance from the energized conductors to buildings and signs
- Distance from the energized conductors to other parallel power lines

The proposed WEC transmission interconnections will be designed to meet all national, state, and local code clearance requirements. Since the designer must take into consideration many different situations, the generalized dimensions provided in the figures of this section should be regarded as reference for the electric and magnetic field calculations only and not absolute. The minimum ground clearance for 69-kV and 115-kV transmission (per General Order [GO] 95) is 30 feet in this area. Under normal conditions, the line operates well below maximum conductor temperature, and thus, the average clearance is greater than the minimum. The minimum ground clearance for 12-kV lines is 25 feet in this area. Regardless of design height, the magnetic and electric field calculations are based on these minimum conductor clearances for the lowest-level conductor and the design spacing of the higher-level conductors relative to the lower-level conductors. This is expected to be the worst-case scenario with actual design conductor heights exceeding those used for this analysis.

5.5.2 Electrical Effects

The electrical effects of high-voltage transmission lines fall into two broad categories: corona effects and field effects. Corona is the ionization of the air that occurs at the surface of the energized conductor and suspension hardware due to very high electric field strength at the surface of the metal during certain conditions. Corona may result in radio and television reception interference, audible noise, light, and production of ozone. Transmission lines are designed with standard practices and components designed to reduce or eliminate the effects of corona. Field effects are the voltages and currents that may be induced in nearby conducting objects. The transmission line’s 60-hertz (Hz) electric and magnetic fields can cause these effects.

5.5.2.1 Electric and Magnetic Fields

Operating power lines, like the energized components of electrical motors, home wiring, lighting, and all other electrical appliances, produce electric and magnetic fields, commonly referred to as EMF. The EMF produced by the alternating current electrical power system in the United States has a frequency of 60 Hz, meaning that the intensity and orientation of the field changes 60 times per second.

The 60-Hz power line fields are considered to be extremely low frequency. Other common frequencies are AM radio, which operates up to 1,600,000 Hz (1,600 kHz); television, 890,000,000 Hz (890 MHz); cellular telephones, 900,000,000 Hz (900 MHz); microwave ovens, 2,450,000,000 Hz (2.4 GHz); and X-rays, about 1 billion, billion (10^{18}) hertz. Higher frequency fields have shorter wavelengths and greater energy in the field. Microwave wavelengths are a few inches long and have enough energy to cause heating in conducting objects. High frequencies, such as X-rays, have enough energy to cause ionization (breaking of molecular bonds). At the 60-Hz frequency associated with electric power transmission, the electric and magnetic fields have a wavelength of 3,100 miles and have very low energy that does not cause heating or ionization. The 60-Hz fields do not radiate, unlike radio-frequency fields.

Electric fields around transmission lines are produced by electrical charges on the energized conductor. Electric field strength is directly proportional to the line's voltage; that is, increased voltage produces a stronger electric field. The electric field is inversely proportional to the distance from the conductors, so that the electric field strength declines as the distance from the conductor increases. The strength of the electric field is measured in units of kilovolts per meter (kV/m). The electric field around a transmission line remains practically steady and is not affected by the common daily and seasonal fluctuations in usage of electricity by customers.

Magnetic fields around transmission lines are produced by the level of current flow, measured in terms of amperes, through the conductors. The magnetic field strength is directly proportional to the current; that is, increased amperes produce a stronger magnetic field. The magnetic field is inversely proportional to the distance from the conductors and, therefore, the strength of the magnetic field rapidly decreases as distance is increased from the conductor. Thus, like the electric field, the magnetic field strength declines as the distance from the conductor increases. Magnetic fields are expressed in units of milligauss (mG). The amperes and, therefore, the magnetic field around a transmission line fluctuate daily and seasonally as the usage of electricity varies.

Considerable research has been conducted over the last 30 years on the possible biological effects and human health effects from EMF. This research has produced many studies that offer no uniform conclusions about whether long-term exposure to EMF is harmful or not. In the absence of conclusive or evocative evidence, some states, including California, have chosen not to specify maximum acceptable levels of EMF. Instead, these states mandate a program of prudent avoidance whereby EMF exposure to the public would be minimized by encouraging electric utilities to use low-cost techniques to reduce the levels of EMF.

5.5.2.2 Audible Noise

Corona is a function of the voltage of the line, the diameter of the conductor, and the condition of the conductor and suspension hardware. The electric field gradient is the rate at which the electric field changes and is directly related to the line voltage.

The electric field gradient is greatest at the surface of the conductor. Large-diameter conductors have lower electric field gradients at the conductor surface and, hence, lower corona than smaller conductors, everything else being equal. Also, irregularities (such as nicks and scrapes on the conductor surface) or sharp edges on suspension hardware concentrate the electric field at these locations and, thus, increase corona at these spots. Similarly, contamination on the conductor surface, such as dust or insects, can cause irregularities that are a source for corona. Raindrops, snow, fog, and condensation are also sources of irregularities. Corona typically becomes a principal design concern for transmission lines having voltages of 345 kV and above.

5.5.2.3 EMF Assumptions

It is important that any discussion of EMF include the assumptions used to assess these values and to remember that EMF in the vicinity of the power lines vary with regard to line design, line loading, distance from the line, and other factors. Both the electric field and audible noise depend upon line voltage, which remains nearly constant for a transmission line during normal operation. A worst-case voltage of 73 kV (69 kV + 5 percent) was used in the calculations for the 69-kV line and 121 kV (115 kV + 5 percent) was used in the calculations for the 115-kV lines.

The magnetic field is proportional to line loading (amperes), which varies as power plant generation is changed by the system operators to meet increases or decreases in demand for electrical power. Line loading values assumed for the EMF studies were based on a 2005 Summer Peak Transmission Assessment Case. The maximum total output of the WEC plant is assumed to be a net generation of 250 MW. The power will be transmitted away from the power plant. A power flow study was conducted, as described in Subsection 5.5.2.3.1, to calculate how the power is expected to distribute over the circuits. The calculated power flow values are tabulated in Subsection 5.5.2.3.1 and are used in the EMF calculations.

Another important parameter for these studies is the phase arrangement of the lines, both existing and after the interconnection is made. The phasing (i.e., relative location of A, B, and C phases) on a multi-circuit structure may offer some field cancellation, which results in reduced magnetic field values at the right-of-way edge. Studies have shown that cross-phasing double-circuit lines provide magnetic field reduction when both circuits are carrying power in the same direction. In cross-phasing, the circuit on one side of the structure is configured, for example, with phases A, B and C arranged from top to bottom, while the other circuit is configured C, B, A from top to bottom.

The data and assumptions used for the EMF studies can be noted from the discussions contained in the following paragraphs and the figures included in the following pages.

Figure 5.5-1 illustrates the plan view of the specific transmission lines represented by the five cross-sections (A, B, C, D, and E) that were included in the EMF studies. Cross-Sections A and D represent the new portions of transmission line that will be constructed to interconnect the WEC to the existing 12-, 69-, and 115-kV lines. Cross-Sections B, C, and E represent the existing 12-, 69-, and 115-kV lines with and without the load flow impacts of the WEC.

Figure 5.5-2 is Cross-Section A and represents the proposed new 115-kV line segments from WEC to the existing Walnut Hilmar 115-kV line on the west side of Washington road. The proposed new line will support the WEC Hilmar 115-kV and the WEC Walnut 115-kV. It is also designed to support 3-phase 12-kV. Cross-Section A view is looking west. The phasing configuration, conductor used, and dimensions assumed for the EMF studies are pictured.

Figure 5.5-3 is Cross-Section B and represents the existing Walnut Hilmar and Walnut Pioneer 115-kV lines, Walnut Industrial 69-kV Lines 1 and 2, and a 12-kV feeder as viewed looking north. After the WEC is constructed, the Walnut Hilmar 115-kV line will be the WEC Hilmar 115-kV, and the Walnut Industrial 69-kV Line 2 will be the WEC Walnut 69-kV line. The phasing configuration, conductor, and dimensions assumed for the EMF studies are pictured.

Cross-Sections C and E are illustrated in Figure 5.5-4 and represent the existing Walnut Industrial 69-kV Line 2 and, for Cross-Section E only, a 12-kV feeder. These cross-section views are looking west. After WEC, Cross-Section C line will be the WEC Walnut 69-kV line, and Cross-Section E will be the WEC Industrial 69-kV line. The phasing configuration, conductor, and dimensions assumed for the EMF studies are pictured.

Figure 5.5-5 is Cross-Section D and represents the proposed new 69-kV line segments from the WEC to the existing Walnut Industrial 69-kV Line 2 due south of the WEC. The proposed new pole line will support the WEC Walnut and the WEC Industrial 69-kV lines. The line is also designed to support new 12-kV feeder conductors extended from Ruble Road for construction power and standby/auxiliary power. This Cross-Section D view is looking south. The phasing configuration, conductor used, and dimensions assumed for the EMF studies are pictured.

5.5.2.3.1 EMF Calculations

EMFs were calculated at 3 feet above flat terrain using FIELDS 1.0, a program developed by Southern California Edison. The FIELDS program uses the basic algorithms for the calculation of electric and magnetic fields listed in the Electric Power Research Institute's *Transmission Line Reference Book*, known as the "Red Book" (pages 330-331, 409-410, and 341-342). The electric field calculation assumes earth as a perfect conductor and sums the vector components of the field created by the charge on each conductor. Likewise, the magnetic field calculation performs a vector sum of the contribution to the field from each of the conductor currents. FIELDS calculates both the square root of the sum of the squares of the vertical and horizontal field components and also the maximum phasor component based upon the magnitude of the major semi-axis of the field ellipse. FIELDS calculates the electric fields expressed as kilovolts per meter (kV/m) and the magnetic fields expressed in milliGauss (mG). The various inputs for the calculations include voltage, current load (amps), current angle (i.e., phasing), conductor type and spacing, number of subconductors, subconductor bundle symmetry, spatial coordinates of the conductors and shield wire, various labeling parameters, and other specifics. The resultant maximum field level is calculated at mid-span where the overhead line sags closest to the ground (calculation point). The mid-span location, therefore, provides the maximum value for the field. Graphs contained in this report were produced by importing FIELDS data into Microsoft Excel.

A power flow model was developed based on TID's 2005 Summer Peak Transmission Assessment Case. Two scenarios were calculated for comparison:

- Without the proposed WEC operating (Base Case)
- With the proposed WEC nominal net generation of 250 MW added (Study Plan)

The variations in the power flow for the studied cross-sections are tabulated in Table 5.5-1.

TABLE 5.5-1
Normal Flows in the Vicinity of the Walnut Energy Center (WEC)
TID 2005 Summer Peak Transmission Assessment Case

Line	Normal Rating (Amps)	Heavy Summer	
		Line Flow Without WEC (Amps)	Line Flow With WEC (Amps)
Hilmar – Walnut 115-kV	816	-408	N/A
WEC – Hilmar 115-kV	816	N/A	416
Walnut – Pioneer 115-kV	816	359	365
WEC – Walnut 115-kV	816	N/A	437
Walnut – Industrial 69-kV Line 2	816	300	N/A
WEC – Walnut 69-kV	816	N/A	394
WEC – Industrial 69-kV	816	N/A	317
Walnut – Industrial 69-kV Line 1	816	333	351
Walnut – Commons 69-kV	816	428	467
Walnut – Fairground 69-kV	816	387	456

Note: All flows are referenced from the first name listed for any line. For example, the values given for Hilmar-Walnut are from Hilmar to Walnut. Based on the pertinence of their location, not all circuits considered for the power flow study were included in the EMF studies.

5.5.2.3.2 Results of EMF and Audible Noise Assessment

Electric Field and Audible Noise

Line voltage and arrangement of the phases determine the electric field. The existing TID lines represented by Cross-Sections B, C, and E have no changes in either the voltage or the phasing; therefore, the electric field in these vicinities will remain the same. The corridor represented by Cross-Section A is the proposed WEC interconnection to the existing 115-kV transmission line. The corridor represented by Cross-Section D is the proposed WEC interconnection to the existing 69-kV transmission line. The results of the electric field for all cross-sections are shown in Figures 5.5-6 through 5.5-10.

The highest levels of corona and, hence, audible noise will occur during foul weather when the line conductors are wet. For these conditions, the conductor will produce a small amount of corona. However, no change in audible noise over the existing 115-kV and 69-kV lines (Cross-Sections B, C, and E) will occur because the conductor and voltages will remain the same as those of the existing system. Cross-Sections A and D will produce audible noise at levels consistent with the existing transmission lines already in this immediate area.

Magnetic Field

The results of the magnetic field calculations for all cross-sections are provided in Figures 5.5-6 through 5.5-10. Figures 5.5-7, 5-8, and 5-10 for Cross-Sections B, C, and E represent existing lines and show the magnetic fields with and without the WEC. Figure 5.5-6 shows the reduction of both magnetic and electric fields that result from the implementation of a cross-phasing conductor arrangement. Table 5.5-2 summarizes calculated values for the magnetic field. For each cross-section, the distance is given where the maximum field value was located.

TABLE 5.5-2
Magnetic Field (mG) Calculated at Mid-span

System at Peak Load	-100	-50	Location of Maximum Value	+50	+100
	Distance from Cross-Section Centerline (feet)				
Cross-Section A	**South of Centerline**		**0**	**North of Centerline**	
Without WEC Plant	n/a	n/a	n/a	n/a	n/a
With WEC Plant	0.42	2.40	13.04	3.17	0.72
Cross-Section B	**West of Centerline**		**5**	**East of Centerline**	
Without WEC Plant	3.53	10.59	33.51	12.27	4.23
With WEC Plant	0.56	2.11	10.56	2.63	0.89
Cross-Section C	**South of Centerline**		**0**	**North of Centerline**	
Without WEC Plant	.956	2.93	8.70	2.90	0.97
With WEC Plant	1.26	3.84	11.42	3.81	1.27
Cross-Section D	**West of Centerline**		**0**	**East of Centerline**	
Without WEC Plant	n/a	n/a	n/a	n/a	n/a
With WEC Plant	**3.91**	**11.62**	**34.60**	**11.80**	**3.95**
Cross-Section E	**South of Centerline**		**5**	**North of Centerline**	
Without WEC Plant	0.94	2.79	7.99	2.76	0.91
With WEC Plant	0.99	2.95	8.35	2.90	0.95

n/a = not applicable.

5.5.2.3.3 Transmission Line EMF Reduction

While the State of California does not set a statutory limit for electric and magnetic field levels, the CPUC, which regulates electric transmission lines, mandates EMF reduction as a practicable design criterion for new and upgraded electrical facilities.

In keeping with the goal of EMF reduction, the interconnection of the WEC will be designed and constructed using the principles commonly followed by electric utilities. Primary techniques for reduction of EMF are:

- Increase the distance between conductors and EMF sensors
- Reduce the spacing between the line conductors
- Minimize the current on the line
- Optimize the configuration of the phases (A, B, C)

Anticipated EMF levels have been calculated for the WEC interconnection as preliminarily designed. The CEC requires actual measurements of pre-interconnection background EMF for comparison with measurements of post-interconnection EMF levels. If required, the pre- and post-interconnection verification measurements will be made consistent with Institute of Electrical and Electronics Engineers (IEEE) guidelines and will provide sample readings of EMF. Additional measurements will be made upon request for locations of particular concern.

5.5.2.3.4 Conclusion on EMF and Audible Noise

In conclusion, for Cross-Sections B, C, and E, there is no change to the existing lines' electric field and audible noise levels, as there is no change to the voltage or line configurations. There is, however, a substantial reduction (23 mG) of magnetic field levels in Cross-Section B because of a change in direction of current in the 69-kV circuits in this line segment (68 percent reduction in maximum field strength and about 80 percent at the 100-foot distance from center line). In Cross-Section C there is an increase of current on the 69-kV system with the WEC and a corresponding increase in the maximum magnetic field strength of 2.7 mG (31 percent). There is less than a 1-mG increase in magnetic field levels for Cross-Section E since the before and after WEC currents are nearly the same. No physical changes to these existing lines are anticipated except for minor changes at the area of interconnection with the proposed WEC interconnection lines (Cross-Sections A and D) and adding a third 12-kV phase to the westernmost portion of the existing single phase 12-kV underbuilt on the Walnut Industrial 69-kV Line 2 on Ruble Road (approximately 1,350 feet).

Cross-Sections A and E increase electric field and calculated noise levels within the corridor since the lines are additions. However, corona, which can produce audible noise, is usually only a nuisance issue with transmission lines at 345 kV and above. In other words, the higher the transmission line voltage, the higher the calculated audible noise levels—whether considered to be at a nuisance level or not. The audible noise levels for Cross-Sections A and E with WEC are consistent with or below the levels of the existing 69-, 115-, and 230-kV lines within this area.

The cross-phase arrangement of the Cross-Section A 115-kV interconnection results in magnetic field values that are 85 percent lower (on average across a +/- 100 feet corridor) than a like phase arrangement. Although implementation of the cross-phase arrangement for Cross-Section A requires a new phase arrangement for a portion of the existing line (from Figure 5.2-1 location on Figure 5.1-2 to the Walnut 115-kV switchyard), the current direction for this line changes with WEC such that minimal magnetic field strength is produced with like-phase arrangement. In other words, rearrangement of the existing 115-kV to accommodate the WEC cross-phase interconnection produces the phase arrangement in the existing line with the lowest magnetic field strength. Since the 69-kV interconnection is only two spans (less than 670 feet in length) of conductor that will be wholly on TID property and is not in close proximity to any building structures, a cross-phasing arrangement (that would require phase changes at the Industrial Substation) is not proposed.

For the proposed interconnections, the hardware used to connect the conductors to the structures will be of low-corona design. Special care will be employed during stringing of the conductor to minimize nicks and scrapes to the conductor. These actions will ensure a low-corona installation.

5.5.2.4 Induced Current and Voltages

A conducting object, such as a vehicle or person in an electric field, will have induced voltages and currents. The strength of the induced current will depend upon the electric field strength, the size and shape of the conducting object, and the object-to-ground resistance. Examples of measured induced currents in a 1-kV/m electric field are about

0.016 milliamperes (mA) for a person, about 0.41 mA for a large school bus, and about 0.63 mA for a large trailer truck.

When a conducting object is isolated from the ground and a grounded person touches the object, a perceptible current or shock may occur as the current flows to ground. Shocks are classified as below-perception, above-perception, secondary, and primary. The mean perception level is 1.0 mA for a 180-pound man and 0.7 mA for a 120-pound woman. Secondary shocks cause no direct physiological harm, but may annoy a person and cause involuntary muscle contraction. The lower average secondary-shock level for an average-sized man is about 2 mA.

Primary shocks can be harmful. Their lower level is described as the current at which 99.5 percent of subjects can still voluntarily "let go" of the shocking electrode. For the 180-pound man this is 9 mA; for the 120-pound woman, 6 mA; and for children, 5 mA. The NESC specifies 5 mA as the maximum allowable short-circuit current to ground from vehicles, trucks, and equipment near transmission lines.

The mitigation for hazardous and nuisance shocks is to ensure that metallic objects on or near the right-of-way are grounded and that sufficient clearances are provided at roadways and parking lots to keep electric fields at these locations sufficiently low to prevent vehicle short-circuit currents from exceeding 5 mA.

Magnetic fields can also induce voltages and currents in conducting objects. Typically, this requires a long metallic object, such as a wire fence or aboveground pipeline that is grounded at only one location. A person who closes an electrical loop by grounding the object at a different location will experience a shock similar to that described above for an ungrounded object. Mitigation for this problem is to ensure multiple grounds on fences or pipelines, especially those that are orientated parallel to the transmission line.

Where railroads are crossed or are parallel to the transmission line, coordination is required with the railroad company to ensure that the magnetically induced voltages and currents in the rails do not interfere with railroad signal and communications circuits, which can be transmitted through the rails. An approximate 1,950-foot section of the 115-kV interconnection (Cross-Section A) line would be located approximately 250 feet south of the Union Pacific Railroad on the northern end of the WEC parcel. Upon final design for the location and various other specifics of this line, further detailed coordination with the railroad company will be initiated.

The proposed 115- and 69-kV transmission interconnections will be constructed in conformance with GO-95 and 8 CCR 2700 requirements. Therefore, hazardous shocks are unlikely to occur as a result of project construction or operation.

5.5.3 Aviation Safety

Federal Aviation Administration (FAA) Regulations, Part 77 establishes standards for determining obstructions in navigable airspace and sets forth requirements for notification of proposed construction. These regulations require FAA notification for any construction over 200 feet in height above ground level. Notification is also required if the obstruction is less than the above-specified height and falls within any restricted airspace in the approach to airports. For airports with runways longer than 3,200 feet, the restricted space extends 20,000 feet (3.8 miles) from the runway. For airports with runways measuring 3,200 feet or less, the restricted space extends 10,000 feet (1.9 miles). For heliports, the restricted space extends 5,000 feet (0.9 mile). No WEC transmission line structures will exceed 110 feet in height.

Three airfields are located within 6 miles of the proposed WEC site. Turlock Air Park is located North of Greenway Avenue, East of Lander Avenue (Highway 165) and South of Highway 99, about 2.9 miles south and east of the WEC site. Because the airfield is less than 3,200 feet in length and more than 10,000 feet from the WEC site, FAA notice is not required. The remaining two airfields are small private landing strips located approximately 4 and 5.2 miles south and east of the WEC site and are, therefore, not subject to FAA notice (see Figure 5.5-11).

Although it may be necessary to notify the FAA due to other tall elements of the project, based on the height of the transmission structures (110 feet maximum) notification is not needed. Furthermore, there are a number of existing transmission lines in proximity and between the WEC site and the identified airfields that are of comparable or taller height. As a result of their location and height in relation to the above airfields, the structures of the proposed electrical transmission interconnection will pose no deterrent to aviation safety as defined in the FAA regulations.

5.5.4 Fire Hazards

The proposed 115- and 69-kV transmission interconnections will be designed, constructed, and maintained in accordance with CPUC General Orders that establish clearances from other man-made and natural structures as well as tree-trimming requirements to mitigate fire hazards. It is not anticipated that the right-of-way for the proposed interconnecting transmission line will have any trees or brush due to its present agricultural land-use activities (see Figure 5.1-2). The Applicant will use trained and qualified maintenance personnel to maintain the interconnection corridor and immediate area of the switchyard in accordance with accepted industry practices that will include recognition and abatement of any fire hazards.

5.6 Applicable Laws, Ordinances, Regulations, and Standards

This section provides a list of applicable laws, ordinances, regulations, and standards (LORS) that apply to the proposed transmission line, substations and engineering. The following compilation of LORS is in response to Section (h) of Appendix B attached to Article 6, of Chapter 6, of Title 20 of the California Code of Regulations. Inclusion of these data is further outlined in the CEC's publication entitled "Rules of Practice and Procedure & Power Plant Site Certification Regulations."

5.6.1 Design and Construction

Table 5.6-1 lists the applicable LORS for the design and construction of the proposed transmission line and substations.

TABLE 5.6-1
Design and Construction LORS

LORS	Applicability	AFC Reference
GO-95, CPUC, "Rules for Overhead Electric Line Construction"	CPUC rule covers required clearances, grounding techniques, maintenance, and inspection requirements.	Section 5.2
Title 8 CCR, Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical installation and equipment to provide practical safety and freedom from danger.	Section 5.2
GO-128, CPUC, "Rules for Construction of Underground Electric Supply and Communications Systems"	Establishes requirements and minimum standards to be used for the station AC power and communications circuits.	Section 5.2
GO-52, CPUC, "Construction and Operation of Power and Communication Lines"	Applies to the design of facilities to provide or mitigate inductive interference.	Section 5.2 Section 5.5.2.1 Section 5.5.2.2 Section 5.5.2.3.3 Section 5.5.2.4
ANSI/IEEE 693, "IEEE Recommended Practices for Seismic Design of Substations"	Recommends design and construction practices.	Section 5.3
IEEE 1119, "IEEE Guide for Fence Safety Clearances in Electric-Supply Stations"	Recommends clearance practices to protect persons outside the facility from electric shock.	Section 5.3
IEEE 998, "Direct Lightning Stroke Shielding of Substations"	Recommends protections for electrical system from direct lightning strokes.	Section 5.3
IEEE 980, "Containment of Oil Spills for Substations"	Recommends preventions for release of fluids into the environment.	Section 5.3

5.6.2 Electric and Magnetic Fields

The applicable LORS pertaining to EMF interference are tabulated in Table 5.6-2.

TABLE 5.6-2
Electric and Magnetic Field LORS

LORS	Applicability	AFC Reference
Decision 93-11-013, CPUC	CPUC position on EMF reduction.	Section 5.5.2 Section 5.5.2.3.3
GO-131-D, CPUC, "Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities in California"	CPUC construction application requirements, including requirements related to EMF reduction.	Section 5.2 Section 5.5.1 Section 5.5.2
ANSI/IEEE 644-1994, "Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines"	Standard procedure for measuring EMF from an electric line that is in service.	Section 5.5.2 Section 5.5.2.3.3

5.6.3 Hazardous Shock

Table 5.6-3 lists the LORS regarding hazardous shock protection that apply to the project.

TABLE 5.6-3
Hazardous Shock LORS

LORS	Applicability	AFC Reference
8 CCR 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation and maintenance of electrical equipment to provide practical safety and freedom from danger.	Section 5.2 Section 5.5.1
ANSI/IEEE 80, "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.	Section 5.3
NESC, ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C.	Covers grounding methods for electrical supply and communications facilities.	Section 5.2 Section 5.5.2.1

5.6.4 Communications Interference

The applicable LORS pertaining to communication interference are tabulated in Table 5.6-4.

TABLE 5.6-4
Communications Interference LORS

LORS	Applicability	AFC Reference
47 CFR 15.25, "Operating Requirements, Incidental Radiation"	Prohibits operations of any device emitting incidental radiation that causes interference to communications. The regulation also requires mitigation for any device that causes interference.	Section 5.2 Section 5.5.2.1 Section 5.5.2.2 Section 5.5.2.3.3 Section 5.5.2.4
GO-52, CPUC	Covers all aspects of the construction, operation, and maintenance of power and communication lines and specifically applies to the prevention or mitigation of inductive interference.	Section 5.2 Section 5.5.2.2 Section 5.5.2.4
CEC staff, Radio Interference and Television Interference (RI-TVI) Criteria (Kern River Cogeneration) Project 82-AFC-2, Final Decision, Compliance Plan 13-7	Prescribes the CEC's RI-TVI mitigation requirements, developed and adopted by the CEC in past citing cases.	Section 5.2 Section 5.5.2.2

5.6.5 Aviation Safety

Table 5.6-5 lists the aviation safety LORS that may apply to the proposed construction and operation of WEC.

TABLE 5.6-5
Aviation Safety LORS

LORS	Applicability	AFC Reference
Title 14 CFR, Part 77, "Objects Affecting Navigable Airspace"	Describes the criteria used to determine whether a "Notice of Proposed Construction or Alteration" (NPCA, FAA Form 7460-1) is required for potential obstruction hazards.	Section 5.2 Section 5.5.3
FAA Advisory Circular No. 70/7460-1G, "Obstruction Marking and Lighting"	Describes the FAA standards for marking and lighting of obstructions as identified by FAA Regulations Part 77.	Section 5.2 Section 5.5.3
PUC, Sections 21656-21660	Discusses the permit requirements for construction of possible obstructions in the vicinity of aircraft landing areas, in navigable airspace, and near the boundary of airports.	Section 5.2 Section 5.5.3

5.6.6 Fire Hazards

Table 5.6-6 tabulates the LORS governing fire hazard protection for the WEC project.

TABLE 5.6-6
Fire Hazard LORS

LORS	Applicability	AFC Reference
14 CCR Sections 1250-1258, "Fire Prevention Standards for Electric Utilities"	Provides specific exemptions from electric pole and tower firebreak and electric conductor clearance standards, and specifies when and where standards apply.	Section 5.2 Section 5.5.4
ANSI/IEEE 80, "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.	Section 5.3 Section 5.5.4
GO-95, CPUC, "Rules for Overhead Electric Line Construction," Section 35	CPUC rule covers all aspects of design, construction, operation, and maintenance of electrical transmission line and fire safety (hazards).	Section 5.2 Section 5.5.4

5.6.7 Jurisdiction

Table 5.6-7 identifies national, state, and local agencies with jurisdiction to issue permits or approvals, conduct inspections, and/or enforce the above-referenced LORS. Table 5.6-7 also identifies the associated responsibilities of these agencies as they relate to the construction and operation of WEC.

TABLE 5.6-7
Jurisdiction

Agency or Jurisdiction	Responsibility
CEC	Jurisdiction over new transmission lines associated with thermal power plants that are 50 megawatts (MW) or more (Public Resources Code [PRC] 25500).
CEC	Jurisdiction of lines out of a thermal power plant to the interconnection point to the utility grid (PRC 25107).
CEC	Jurisdiction over modifications of existing facilities that increase peak operating voltage or peak kilowatt capacity 25 percent (PRC 25123).
FAA	Establishes regulations for marking and lighting of obstructions in navigable airspace (AC No. 70/7460-1G).
Local Electrical Inspector	Jurisdiction over safety inspection of electrical installations that connect to the supply of electricity (NFPA 70).
County of Stanislaus	Establishes and enforces zoning regulations for specific land uses. Issues variances in accordance with zoning ordinances. Issues and enforces certain ordinances and regulations concerning fire prevention and electrical inspection.

5.7 References

California Energy Commission. Rules of Practice and Procedure and Power Plant Site Certification Regulations.

California Public Service Commission, Decision 93-11-013.

California Public Service Commission, General Order 52—Construction and Operation of Power and Communication Lines.

California Public Service Commission, General Order 95—Rules for Overhead Electric Line Construction.

California Public Service Commission, General Order 128—Rules for Construction of Underground Electric Supply and Communications Systems.

California Public Service Commission, General Order 131D—Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities.

Electric Power Research Institute. 1975. *Transmission Line Reference Book, 345-kV and Above*. Palo Alto.

Electric Power Research Institute. 1978. *Transmission Line Reference Book, 115-138-kV Compact Line Design.* Palo Alto.

IEEE Power Engineering Society. 1985. Corona and Field Effects of AC Overhead Transmission Lines, Information for Decision Makers. July.

National Electrical Safety Code, ANSI C2.

Southwire. *Overhead Conductor Manual*.

U.S. Department of Energy. 1989. *Electrical and Biological Effects of Transmission Lines, A Review*. Bonneville Power Administration, Portland, Oregon. June.

FIGURE 5.1-1
Regional Transmission Resources in the Vicinity of the Proposed Walnut Energy Center and Proposed Interconnection Route Alignment

FIGURE 5.1-2
Regional Transmission Resources in the Vicinity of the Proposed Walnut Energy Center and Proposed Interconnection Route Alignment (Aerial Photography Format)

FIGURE 5.2-1
Section AA - 115kV Typical Double-Circuit Deadend/Angle Steel Structure with 12 kV Underbuild

FIGURE 5.2-2
Section BB - 69 kV Typical Double-Circuit Deadend/Angle Steel Structure with 12 kV Underbuild

FIGURE 5.3-1
Single Line Diagram for 115 kV and 69 kV Switchyard

FIGURE 5.5-1
EMF Study Cross Sections

FIGURE 5-1
Regional Transmission Resources in the Vicinity of the Proposed Walnut Energy Center and Proposed Interconnection Route Alignment

FIGURE 5-1
Regional Transmission Resources in the Vicinity of the Proposed Walnut Energy Center and Proposed Interconnection Route Alignment

FIGURE 5.5-2
Section A 115kV typical Double Circuit Structure with 12 kV Underbuild

FIGURE 5.5-3
Section B 115 and 69 kV typical Double-circuit Structure with 12 kV Underbuild

FIGURE 5.5-4
Sections C & E 69 kV Typical Single Circuit Structure with 12 kV Underbuild

FIGURE 5.5-5
Section D 69 kV Typical Double Circuit Structure

FIGURE 5.5-6
Section A, Magnetic and Electric Field

FIGURE 5.5-7
Section B, Magnetic and Electric Field

FIGURE 5.5-8
Section C, Magnetic and Electric Field

FIGURE 5.5-9
Section D, Magnetic and Electric Field

FIGURE 5.5-10
Section E, Magnetic and Electric Field

FIGURE 5.5-11
Airfields in Proximity to WEC Site

MAP INSERT 1

MAP INSERT 2